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OLDMAN RIVER DAM

PHASE I: VEGETATION OVERVIEW
ECOLOGICAL COMPONENT
ENVIRONMENTAL MITIGATION/OPPORTUNITIES PLAN

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SUMMARY

A dam and reservoir on the Oldman River is to be constructed by the Government of Alberta to provide water for multipurpose use including irrigation. The purpose of this report is to provide an overview of existing information on the vegetation of the project area. Methods used included review of literature and maps, air photo interpretation and telephone interviews. A vegetation map of the reservoir and surrounding area was prepared at a scale of 1:31 630.

The vegetation of the Three Rivers site and Oldman River downstream to the Peigan Indian Reserve consists of 6 major communities ranging from grassland, through deciduous shrubs to deciduous and coniferous forests. The most abundant vegetation type covering 70.2% of the reservoir is fescue-oat grass. Poplar along the river floodplain is the second most abundant vegetation type covering 10.4% of the reservoir. The remaining 8.9% of the area is occupied by a mosaic of snowberry - silverberry, Douglas fir and aspen. Cultivated lands make up the remaining 10.5% of the reservoir. The limber pine - lodgepole pine type is not found in the reservoir.

The distribution of vegetation is controlled primarily by chinook winds, grazing intensity and river regime. The strong, dry, westerly winds along with the associated high rates of evaporation severely restricts growth of woody vegetation such that it is found mainly on sheltered north and east facing slopes of the uplands and valley slopes. The grasslands as well as the shrub and forest vegetation types may be considerably affected by grazing, browsing and trampling by cattle. In addition, removal of vegetation by grazing and

trampling combined with winds and summer rainfall are the most significant causes of soil erosion in the area. Poplar stands along the valley bottoms of the Crowsnest, Castle and particularly the Oldman River are dependent on the annual flooding, erosion and sedimentation events for establishment and growth.

Revegetation practices both for the establishment of shelterbelts and reclamation of disturbed areas have been developed and tested in the Pincher Creek area for many years. Multiple row shelterbelts of caragana, green ash, Brooks poplar and Colorado spruce are recommended by Alberta Agriculture. The use of these species along with proper cultivation practices to conserve moisture, prevent livestock damage and control weeds will greatly aid in the survival and growth of effective shelterbelts. As well, irrigation techniques will considerably improve the rate of shelterbelt growth and establishment.

Revegetation of areas disturbed during construction of the dam can be accomplished by use of the appropriate seed mix of grass and legumes depending on soil moisture and slope conditions. Revegetation methods including topsoil salvage, site preparation, proper seed application and fertilization will improve revegetation efforts. If necessary mulches, tackifiers and/or erosion control mats could be used to aid revegetation and prevent soil loss.

Detailed vegetation information for the Oldman River area is generally lacking, and many of the community descriptions presented here are largely based on more regional studies done over 40 years ago. As a result information on species composition and cover; ecological relationships of vegetation to major controlling factors; uniqueness or rarity of species or communities; and utilization of vegetation by wildlife is unknown.

Recommendations for further studies of vegetation are necessary to understand the existing conditions, as well as to assess to potential effects of the project and to design mitigative measures. The following is a list of recommended studies:

1) Vegetation inventory of species cover and composition;

2) Ecological studies of effects of chinook winds, grazing, and river regime;

3) Preparation of vegetation map at a scale of 1:10 000 to 1:20 000;

4) Shelterbelt assessment to determine species performance and best cultural techniques;

5) Impact assessment and design of mitigative measures; and

6) Development of a long term monitoring program to evaluate river regime and related vegetation changes downstream of the dam.

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1.0 INTRODUCTION

The Government of Alberta announced in mid summer 1985 that a dam will be constructed on the Oldman River at the Three Rivers Site, to provide a dependable water supply for multipurpose use and to permit substantial expansion of irrigation in southwestern Alberta. The Planning Division of Alberta Environment is preparing an Environmental Mitigation/ Opportunities Plan for the project. The mitigation plan will be completed in three general phases: overview of existing information, data collection, and identification of possible mitigation strategies.

The following report is the first phase overview of existing information for vegetation. The vegetation overview covers the potential reservoir area near the confluence of the Oldman, Crowsnest and Castle rivers just north of Pincher Creek, and the downstream riparian habitats within the Oldman River valley east of the dam site to the western boundary of the Peigan Indian Reserve (Figure 1).

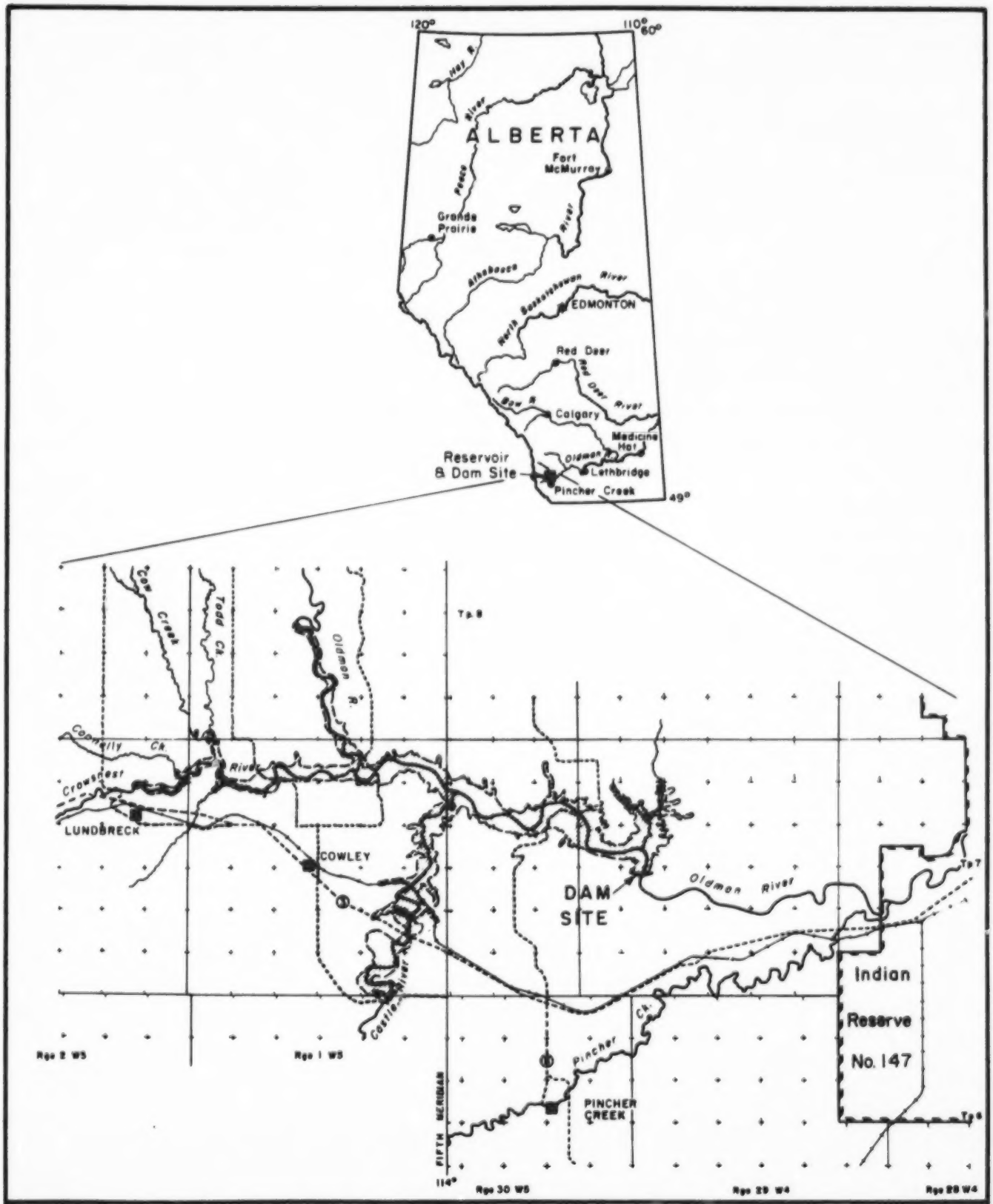
1.1 STUDY OBJECTIVE

The purpose of the study is to compile an overview of existing vegetation information in the Oldman River dam area. This overview will be the information base for the later design of a detailed vegetation survey to be conducted in 1985. The major objectives are:

1) To collect and review previous information and identify data gaps;

2) To identify and document natural plant communities and their relationships with ecological factors;

3) To identify and document rare plant species, stands or communities likely to be found in the area; and



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OLDMAN RIVER DAM SITE AND RESERVOIR

FIG. 1

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4) To review local revegetation efforts, which could provide some insight into the feasibility and design of revegetation test plots.

1.2 METHODS

The following report is entirely based on office studies consisting of review of existing information and air photo interpretation. All available bibliographies, reports, and maps dealing with the study area and often more broadly to southwestern Alberta were collected and reviewed. Sources included the libraries of the University of Calgary, Alberta Research Council, Alberta Environment as well as Hardy Associates in-house collection of vegetation and revegetation information. Telephone interviews were conducted with personnel of Alberta Agriculture and Alberta Transportation familiar with the area.

In order to provide a preliminary map of native vegetation, black and white air photos were obtained. Most of the interpretation of native vegetation types was done on photography from 1972 and 1974 at scales of 1:21 120 and 1:24 000 respectively. Black and white air photos from 1981 and 1982 at a scale of 1:60 000 were examined and used to update land use patterns, particularly areas of native pasture which may have subsequently been cultivated. The mapped area generally was extended beyond the reservoir limit to the nearest section or half section line.

The boundaries and annotation for the major vegetation types were then transferred from the air photos (1972 and 1974) to a mylar copy of a mosaic of the study area at a scale of 1:31 680. The mosaic was extended to the east along the Oldman River valley as far as the boundary of the Peigan Indian Reserve. The area of each vegetation type below the full supply level was measured using a computerized digitizer.

Total areas of each type were summarized in tabular form to show potential vegetation losses in the reservoir.

1.3 PLAN OF THE REPORT

The report on vegetation of the Oldman River area is divided into six major parts. The first part is a description of the major vegetation types in the area, which is followed by a section on dominant ecological factors controlling vegetation. The third part is a brief review of the potential for rare plants, while the fourth part discusses revegetation efforts in the area with particular reference to shelterbelts. Part five identifies the important data gaps, while part six concludes the report recommendations for further work.

2.0 MAJOR VEGETATION TYPES

The vegetation of the Oldman River area lies predominantly in the Fescue Grass Ecoregion (Strong and Leggat 1981). The area, which lies between the aspen parkland to the north and the drier mixed grass region to the south and east, is characterized by rough fescue and parry oat grass. Many of the sheltered positions provided by the rolling topography and the three river valleys are occupied by woody vegetation. North and east facing slopes of valleys and coulees, slough depressions, ridges and knolls may be covered by shrubs such as snowberry and silverberry, and trees including aspen, Douglas fir, limber pine and lodgepole pine. The flats of streams and rivers are commonly occupied by poplar species including hybrids (Brayshaw 1965).

The soils of the area are typically orthic black chernozems which have developed on a variety of lacustrine, morainal and glaciofluvial deposits. Ridges and knolls, valley slopes and floodplains have minimal soil development and are classified as regosols.

The most important factor controlling vegetation is the climatic regime characterized by strong winds and high rates of evaporation. The prevailing winds are westerly, of high velocity, warm and extremely dry. The area receives long hours of sunshine throughout the year, and the average precipitation is 290 mm in the May to September period which accounts for just over 60% of the total (Strong and Leggat 1981).

The six major vegetation types range from fescue grasslands, through deciduous shrubs to coniferous and deciduous forest communities. The location and extent of each of the major types is shown on Map 1 (map pocket at back). A list of common and botanical names is presented in Appendix A, from Moss (1983).

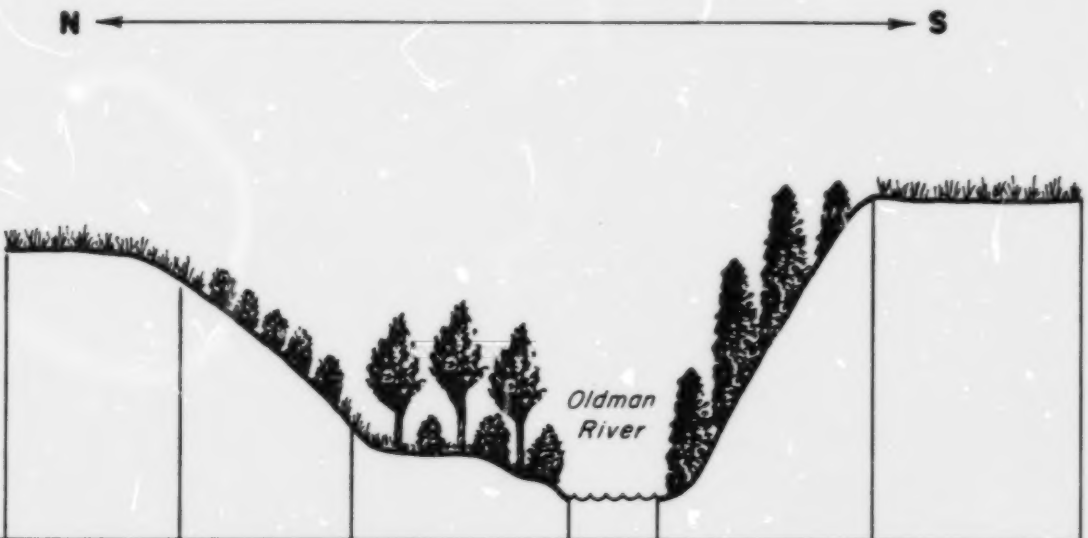
The following descriptions emphasize the floristics and structure and include notes on site conditions and successional status. The species are listed alphabetically in each type since data on dominance of individual groups was limited. The vegetation can be broadly considered to characterize two distinctive site conditions based on landform and direction which slopes face. The typical vegetation of the broad and deep Oldman River valley oriented east-west is shown on Figure 2, while the vegetation typical of the narrow steep sided Oldman River valley north of Cowley oriented north-south is shown on Figure 3. This later pattern of vegetation is also common on the Castle and Crowsnest River valleys.

Fescue-oat grass

This type represents a grassland dominated by the grasses rough fescue and oat grass which form distinctive bunches or tussocks, between which herbs and a few scattered shrubs are found. The primary species are (Moss 1944, Moss and Campbell 1947):

Shrubs	Grasses	Herbs
rose	bluebunch fescue	balsam root
shrubby cinquefoil	Parry oatgrass	blazing star
	rough fescue	Columbia puccoon
	slender wheat grass	death camas
	wild oat grass	perennial lupine
		sticky purple geranium
		yellow hedysarum

The fescue-oat grass type is found on most landforms in the area including lacustrine, moraine and fluvialglacial plains as well as on higher terraces in the river valleys and on eroding valley slopes. The rich black soils (orthic black chernozems) are moderately well drained coarse to fine loam to clay textured materials. The vegetation type



Vegetation Type	Fescue-oat grass	Snowberry-silverberry, Fescue-oat grass	Poplar and Willow		Douglas Fir	Fescue-oat grass
Landform	Lacustrine plain with eroded slopes		Fluvial flood plain		Colluvial Slope	Moraine plain
Drainage	Moderately well	Well to rapid	Imperfect		Moderately well	Well
Dominant Soils	Orthic black chernozem		Orthic regosol		Regosol	Orthic black chernozem

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TYPICAL VEGETATION OF THE OLDMAN RIVER VALLEY NEAR BROCKET

FIG. 2

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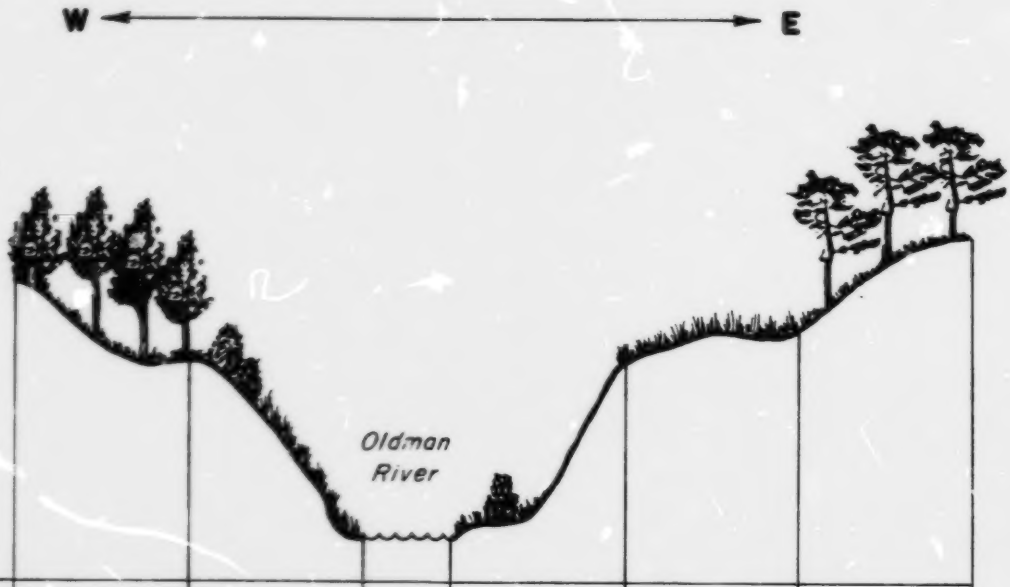

Vegetation Type	Aspen	Fescue-oat grass		Barren, Fescue-oat grass	Fescue-oat grass	Limberpine-Lodgepole pine
Landform	Rolling moraine plain			Coliuvial slope	Lacustrine plain	Moraine veneer over Bedrock
Drainage	Moderately well	Well to rapid		Well to rapid	Moderately well	Well
Dominant Soils	Orthic black chernozem			Regosol	Orthic black chernozem	Orthic regosol

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TYPICAL VEGETATION OF THE OLDMAN RIVER VALLEY NORTH OF COWLEY

FIG. 3

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represents the regional climax for most parts of the black soil zone and is well suited to tolerate open, south and west facing slopes subject to drying winds. Occasional grass fires burn the area and arrest the invasion of shrubs and trees. Grazing is the predominant use of the grassland, and much of the level to gently sloping areas have been cultivated for grain crop production. The fescue-oat grass type covers approximately 1753 ha or 70% of the reservoir area (Table 1).

Snowberry-Silverberry

This type consists of an open to dense clump of shrubs that are usually located within the fescue-oat grass vegetation type. The primary species are (Moss 1944):

Shrubs

chokecherry
saskatoon
silverberry
snowberry

This shrub type is frequently found on north to northeast facing gentle to strongly rolling slopes of lacustrine, morainal, fluvialglacial deposits and fluvial terraces. The soils are moderately well to well drained with a coarse-fine loam and clay texture. These cooler aspect slopes accumulate snow which melts late in the spring providing moisture well into the summer. The shrub communities are not only limited by climate, but are periodically severely reduced by grass fires and heavy grazing.

TABLE 1

APPROXIMATE AREAS OF THE VEGETATION TYPES IN THE OLDMAN RIVER RESERVOIR

	Vegetation Type	Area (ha)	Approximate % of total Reservoir Area
1	Fescue-oat grass	1753.4	70.2
2	Snowberry-silverberry	128.7	5.1
3	Poplars	261.6	10.4
4	Aspen	11.2	0.4
5	Limber pine-lodgepole pine	0	-
6	Douglas fir	89.8	3.4
C	Cultivated	263.4	10.5
GP	Gravel Pit	0	-
	TOTALS	2508.1	100

Poplars

This vegetation type represents open to closed stands of hybrid poplars with numerous shrubs and minor herbs. The primary species are (Moss 1944, Brayshaw 1965 and Wallis 1976):

Trees	Shrubs
balsam poplar	red osier
narrow-leaf cottonwood	river alder
	water birch
	willows

The poplar stands occupy narrow bands along the Crowsnest and Castle rivers, and reach their largest extent along the broad floodplain of the Oldman River below the dam site. The type occupies fluvial floodplains and older point bar deposits where the sandy fine loam to gravel soils are moderately well drained except during snowmelt and periods of high precipitation. Next to the poplar type on more recent sand bars is often a sandbar willow community with a ground cover of horsetail and sweet clover. The sites are subject to annual flooding, sedimentation, erosion and ice scour, as well as occasional beaver logging. The poplar type is used extensively to shelter farm buildings, houses and livestock from the strong winds. As a result the understory often is trampled and heavily grazed.

Aspen

This type represents small stunted "groves" of aspen that together with the associated prairie form a parkland. The primary species are (Strong 1979 and Moss 1944):

Trees	Shrubs	Herbs
aspen	roses	fireweed
	saskatoon	meadow rues
	willows	northern bedstraw
		strawberries
		western Canada violet

This vegetation type occurs on north and east facing slopes and at the base of steep slopes on fluvial terraces. The soils are moderately well drained on loam and clay textured materials. Aspen stands are quite rare in the study area, not only due to the dry climate, but also due to fire and grazing which prevents aspen from invading and eventually dominating the snowberry-silverberry type which grows in similar site conditions.

Limber Pine - Lodgepole Pine

This type represents an open stand of pine with a ground cover of low shrubs and herbs. The dominant tree species are limber pine and lodgepole pine which commonly shows a dwarfed and distorted habit with extensive killing of branches on the windward side of the crown. The primary species are (Moss 1944):

Trees	Low Shrubs	Herbs
limber pine	common bearberry	blue phlox
lodgepole pine	creeping juniper	double bladder-pad
	ground juniper	milk vetch
		musineon
		stonecrop
		yellow umbrella plant

This vegetation type occurs on the slopes and drier slopes of ridges and on rock outcroppings (Moss 1944). The soils are well to rapidly drained on coarse textured materials which has developed from weathered sandstone and shale, where groundwater is available to the tree roots. The pine type with the fescue-oat grass forms a parkland on higher ridges and knolls and is subject to grazing and trampling by livestock as well as occasional fires. The current infestation by the mountain pine beetle has resulted in the death of many pine and occasional sanitation logging of stands.

Douglas Fir

This type occurs as a closed, relatively tall coniferous stand of Douglas fir with a distinct shrub and herb layer which varies depending on the denseness of the tree cover. The primary species are (Moss 1944):

Trees	Shrubs	Herbs
Douglas fir	mountain maple	bluejoint
	roses	Columbia clematis
	saskatoon	cow parsnip
	snowberry	fowl bluegrass
	thimbleberry	showy aster
		slender wheat grass

This vegetation type occurs on north to northwest facing moderate to steep slopes of colluvium. The soils are well drained on gravelly sand textured materials. These Douglas fir stands grow in close association with the snowberry-silverberry and aspen types on lower slopes due to the protection and moisture provided by the north facing slopes. In addition to disturbances caused by grazing and fire, some of the steep slopes on the outside of river bends are subject to river undercutting and landslide type erosion.

Cultivated

This type represents areas of land utilized for agriculture such as grain crops, hay crops, summer fallow and improved pasture, as well as farmsteads and buildings. This unit occurs on level to gently rolling lacustrine, fluvioglacial, morainal deposits and fluvial terraces, where the orthic black chernozem soils are moderately well drained, coarse-fine loam and clay textured materials.

Gravel Pit

Several gravel pits are located on the fluviolglacial deposits on the south side of the Oldman river west of Brocket. The pits are in various stages of development from active to abandoned.

3.0 DOMINANT FACTORS CONTROLLING VEGETATION

The dominant factors controlling vegetation on a regional basis are climate, topography and soils. Thus the study area is a predominately grassland area due to the dry environment, however, variations in topography and soil moisture create conditions suitable for the growth of shrubs and trees as described above. The distribution of vegetation is modified on a local basis in the project area often as the result of chinook winds, fire and grazing on the uplands as well as flooding, sedimentation and beaver logging along the river valleys.

3.1 CHINOOK WINDS

The high speed, warm, dry chinook winds blowing out of the Crowsnest Pass make the project area one of the most windy in Alberta. During the winter, these winds produce rapid elevations in temperature and quick melting of snow. Indirectly they may produce winter killing of plants by breaking of dormancy prior to the normal growing season. In the spring, they may increase the availability of moisture by rendering the soil more receptive to rain and melting snow.

During summer, these winds have a very marked desiccating effect on soil and vegetation and as a result may initiate or increase soil erosion from cultivated fields and steep slopes. The area around the junctions of the three rivers (Oldman, Castle and Crowsnest) is subject to persistent wind action from the west or west southwest, which has resulted in numerous areas of bare ground that are subject to sheet wash and rill erosion during rainstorms (Northwest Hydraulic Consultants Ltd. 1980). Features of this type are seen particularly along the east side of the Castle River near the Canadian Pacific Railway, and along the

north side of the Crowsnest River and its tributary valleys east of Lundbreck. This type of erosion coupled with that induced by vegetation removal due to cattle grazing discussed below is considered by Northwest Hydraulic Consultants Ltd. (1980) as being the most significant erosion process in the study area.

3.2 FIRE

Historically fire has been the major factor in limiting the growth of woody species in the prairie region. Moss (1944) reports that the aspen stands that he investigated tended to be even-aged and rather young owing to the burning of areas in comparitively recent years. There are no reported recent occurrences of fires in the reservoir area, however grass fires on the uplands are common (L. Allison, pers. comm.).

3.3 GRAZING

Domestic grazing is common throughout the area and tends to inhibit the growth of woody vegetation. The use of the poplar areas for grazing depends on access and local livestock management. On some flats, cattle use the area throughout the summer because of the proximity of the river, and are often wintered on the flats as well. In the later case, grasses and herbs as well as shrubs are eaten or trampled, and young trees are pushed over and root systems damaged. By removal of surface vegetation and trampling by cattle contribute to soil erosion on river banks and steep slopes.

3.4 RIVER EROSION AND SEDIMENTATION

River channel shifting and the process of exchanging sediment between eroding banks, and depositing bars and banks a short distance downstream is not an important feature of the Oldman River in the study area (Northwest Hydraulic Consultants Ltd. 1980). In a study of the Milk River, in a similar environment but smaller size, Bradley (1982) found that rates of river channel migration to be 1.8 m/yr, while on the Red Deer River which is of comparable size to the Oldman, Neill and Galay (1967) found the rate to be 3 m/yr. Rates of floodplain sedimentation along the Milk River changed from an initial 16 cm/yr for the first 10 years following formation of the point bar, to 2 cm/yr over a 70 yr period based on an analysis of cottonwood ages (Bradley 1982). Similar rates may be expected along the Oldman River.

3.5 BEAVER LOGGING

Beaver logging currently occurs throughout the poplar stands along the river valleys (L. Allison, pers. comm.). This activity in conjunction with heavy grazing by livestock may result in the elimination of poplar from some floodplain areas.

4.0 UNIQUE COMMUNITIES AND RARE PLANTS

A unique cacti community located at the confluence of the Castle and Oldman rivers was reported by Lombard North Group (1978). This community may be unique because cacti are not among the dominant species listed for the area (Moss 1944). None of the species listed for the study area by Moss (1944) are considered to be rare, as defined by Argus and White (1978) and Packer and Bradley (1984).

On the basis of the small distribution maps provided by Packer and Bradley (1984), the following are thirteen rare species that may occur in the study area:

Danathonia unispicata (one-spike oat grass)
Festuca occidentalis (western fescue)
Glyceria elata (tall manna grass)
Trisetum cernuum (nodding trisetum)
Juncus nevadensis (Nevada rush)
Pterospora andromedia (pine-drops)
Hydrophyllum capitatum (woolen-breeches)
Nemophilia breviflora (small baby-blue-eyes)
Phacelia linearis (narrow-leaved scorpion weed)
Mertensia lanceolata (prairie or narrow-leaved lungwort)
Penstemon eriantherus (crested beard-tongue)
Aster campestris (meadow aster)
Stephanomeria runcinata (rush-pink)

5.0 REVEGETATION OVERVIEW

As a result of the proposed dam and reservoir development several farmsteads will be flooded. The owners who will have to move to the uplands surrounding the reservoir, are concerned that suitable farm shelter belts must be developed to provide protection from the wind. In addition, areas disturbed during the construction phase will require revegetation to prevent soil erosion. The following is a brief overview of current practices and recommended shelterbelt and revegetation procedures in the Pincher Creek area.

5.1 SHELTERBELTS

Shelterbelts have been grown and maintained in the Pincher Creek area for many years to provide shelter from the prevailing west winds and several are found in the uplands adjacent to the reservoir site. The basic procedures for planting and establishing shelterbelts are described in detail in Alberta Agriculture (1982, 1984), and the following is a summary of the major steps.

Multiple row shelterbelts are best placed at least 30 m from the nearest building or driveway on the windward side. Starting on the windward side the belt should consist of a hedge, next a row of poplar, next a slower growing deciduous tree and finally a coniferous tree. The rows should be spaced 5-7 m apart with space between the individual plants varying depending on the species. The land should be summerfallowed one year before planting to reduce weed competition and conserve moisture. Shallow cultivation to control weeds between the rows is needed for several years, or herbicides may be applied to control weeds if special care is used. The shelterbelts must be fenced to prevent livestock damage. Thinning, topping, replanting and possibly spraying for insects may be necessary to maintain the shelterbelts.

In the Pincher Creek area multiple row shelter belts oriented north-south and made up of caragana, green ash, Brooks poplar and colorado spruce have proven to be the most successful combinations (R. Lyons, pers. comm.) The following is Alberta Agriculture's recommended procedure for the area. The rows should be spaced 4 m apart, be 150 m long and the last row of spruce be planted some 5 years after the establishment of the hedge and deciduous trees. In addition to summerfallow the year prior to planting, a snow fence should be placed on the extreme west side to trap snow which will provide moisture for spring planting. Although not necessary for survival, irrigation from a drip type system would aid considerably in the successful establishment and rapid growth of the shelterbelt. Without irrigation the poplar often dies out after some 15 years and needs to be removed and if desired replaced.

Long term maintenance of shelterbelts generally requires annual weed control, and if necessary, spraying to control insects. Mice which girdle stems under the snow may need to be controlled by poison bait applied in the fall. Other species such as willow, honeysuckle and lilac can survive but generally are slow growing and short lived. Field shelterbelts are more difficult to establish because of the cost of fencing to prevent livestock damage, and the danger of drifting herbicide spray killing the trees and shrubs.

5.2 REVEGETATION

5.2.1 Alberta Transportation Experience

To revegetate roadside ditches and highway embankments with little or no topsoil, Alberta Transportation (K. Danchuk, pers. comm.) has found the following mix to be effective.

Species	Proportion by Weight (%)
crested wheat grass	40
intermediate wheat grass	20
bromegrass	20
timothy	10
alfalfa	5
alsike clover	5
	100

Seeding is done by hydroseeder in April-May or September to take advantage of available soil moisture. If a lower growing and denser grass cover is required, the mix should be altered to include creeping red fescue.

5.2.2 Revegetation Seed Mixes and Methods

The following summary of seed mixes and revegetation methods is developed from Hardy Associates considerable experience in revegetating surface disturbance in southern Alberta including pipelines, borrow pits and coal mines.

5.2.2.1 Seed Mixes

In the study area site conditions lend themselves to categorization into two major types based on moisture regime. A mix for mesic conditions consisting of flat to gently rolling area with fine textured soils is as follows:

Species	Proportion by weight %
Boreal creeping red fescue	25
Clark intermediate wheat grass	30
Carlton smooth bromegrass	30
Climax timothy	10
Aurora alsike clover	5
	100

A mix for dry site conditions consisting of steep slopes, west and south facing slopes and/or coarse texture (sand and gravel) soils is as follows:

Species	Proportion by weight %
Nordan crested wheat grass	32
Cabrie Russian wild rye	32
Sodar streambank wheat grass	32
Rambler alfalfa	4
	100

5.2.2.2 Revegetation Methods

Application Rate

Broadcast application rates should be 30 kg/ha on level areas, up to 60 kg/ha on slopes greater than 10%, with medium to fine textured soils.

Fertilizer

Fertilizer should be applied at the time of seeding. The formulation and rate should be determined following chemical analysis of representative samples of surface soil.

Site Preparation

Where available, topsoil should be replaced on all surfaces. Where topsoil is not available or in short supply, medium to fine textured overburden may also be used to dress the granular or coarse textured surface. Replacement depths will vary from site to site but will generally be greater on regraded slopes than on level surfaces, with 30 to 40 cm being optimum, although lesser depths (4 to 5 cm) will greatly enhance vegetation establishment.

Sloped surfaces should be scarified perpendicular to slope gradients. On sites with coarse textured material, the impressions left by bulldozer tracks often provide sufficient microsites for seed. On sites with fine textured soils, microsites are best created by shallow ripping, discing or cultivating. Grading to a smooth surface is not desirable as the potential for runoff, erosion, or crusting and creation of a poor seedbed is increased.

Application

The method of application will depend on site condition, location etc. Drill seeding is highly recommended, however due to slope conditions this may not be feasible. Hydroseeding is the next best method of application for sloped and level areas. It also provides the flexibility of using hydro mulches and tackifiers. Dry broadcast of seed and fertilizer is an acceptable and widely used method, particularily on small sites. Harrowing or raking following seeding will improve seed germination ad establishment and is highly recommended. The rate of seed application for hydroseeding and dry broadcast should be double the drill application rate to compensate for the lack of control in seed placement.

Mulches, Tackifiers and Erosion Control Mats

Mulches and tackifiers help to retain soil moisture, protects the surface soil from erosion by wind and water, holds seed in place and helps stabilize surface soil temperatures. Commercially available mulches such as woodfiber or straw may be considered on dry, potentially difficult revegetation sites such as west and south facing slopes.

Under severe site conditions, the erosion potential may warrant the use of erosion control mats. These mats are stronger and longer lasting than muclhes. Erosion control mats have been used very successfully along waterways and other highly erodible areas. In general, they are too expensive and difficult to handle for large-scale application and are used only on critical areas. Good surface contact is essential, therefore, preliminary seedbed preparation is important. Products which may be considered include:

- Curlex blankets (interlocking, curled, barbed aspen fibers);
- Soil saver (heavy jute mesh);
- Conwed netting (plastic mesh); or
- Burlap sack.

5.3 RECOMMENDED REVEGETATION PRACTICES

The design and establishment of revegetation test plots in the Pincher Creek area does not appear to be warranted in view of the local experience shown by Alberta Agriculture, Alberta Transportation and other disturbances including pipelines. Although the planting and maintenance of shelterbelts has to be done carefully, proper species selection (caraganas, green ash, Brooks poplar and Colorado spruce) and proper cultivation practices (summerfallow, snowfence, protection from

livestock and weed control) will ensure a high rate of survival. Growth and survival particularly in dry summers can be enhanced if irrigation in the form of a drip type system is used.

Revegetation of areas disturbed by dam construction as well as borrow pits can be accomplished using the appropriate seed mix. Success of revegetation efforts will be considerably increased by topsoil salvage, proper site preparation and fertilizer. Application is best by seed drill, however hydroseeding and dry broadcast methods are acceptable on steep slopes. Mulches, tackifiers and/or erosion control mats may be necessary under moderate to severe site conditions to aid seedling establishment and prevent soil loss.

6.0 DATA GAPS

There are major data gaps with respect to the vegetation of the proposed dam site. Detailed vegetation descriptions in the vicinity of the area are over 40 years old (Moss 1944). The following are not known:

1) Knowledge of the detailed species composition and cover of the major vegetation types in the area;

2) Detailed knowledge of the relationships of the vegetation communities to important local controlling factors including chinook winds, grazing by livestock and river regime;

3) Knowledge of the rarity or uniqueness of plant species or communities in a regional context; and

4) Information on the utilization of vegetation communities by wildlife such as beaver and deer.

7.0 RECOMMENDATIONS FOR FURTHER WORK

A more detailed knowledge of the composition, distribution and ecological relationships of the vegetation types will aid in the understanding of the use of the area for wildlife; provide data on the extent of each type flooded by the reservoir; and will allow the assessment of impacts, design of mitigative measures and development of programs to monitor the long term effects of the project. The following studies are recommended:

1) Vegetation Inventory: An inventory of the present vegetation in the study area in relation to landforms and soils, as well as local controlling factors such as chinook winds, grazing and river regime should be undertaken. The inventory should be based on interpretation of low level aerial photography (preferably false colour infrared or true colour) and detailed field checking in both the reservoir and downstream areas.

   Low level (1:20 000) colour aerial photography taken in 1983 and 1984 is available for part of the west half of the reservoir area from the National Air Photo Library in Ottawa. Additional photography at this scale would be needed to complete the coverage of the reservoir and downstream river valley.

2) Ecological Studies: The relationship between the riparian vegetation patterns and river regime such as flow, channel migration and sedimentation should be investigated particularly in the downstream area as a means of providing baseline data on which to monitor the long term effects of the project. The study should consist of air photo interpretation and field checks to be conducted concurrent with the vegetation inventory.

3) Vegetation Map: A reasonably detailed vegetation map of the reservoir and downstream area should be prepared after the inventory at a scale of 1:10 000 to 1:20 000. The map will aid in the assessment of wildlife habitat and vegetation types lost by flooding.

4) Shelterbelt Survey: A survey of existing shelterbelts in the vicinity of the project should be conducted to obtain information useful for recommending practical and effective revegetation measures. Data on species composition, longevity, planting and maintenance techniques, and irrigation methods should be collected.

5) Impact Assessment and Mitigative Measures: The impacts and design of mitigative measures would focus primarily on vegetation loss, revegetation, erosion control and potential vegetation changes downstream of the dam.

6) Monitoring: A program for monitoring the long term effects of the project on riparian vegetation downstream of the dam due to altered river regime should be developed. Elements of the program should include permanent transects where data on channel migration, sedimentation, seedling establishment and vegetation growth are collected periodically (every 3 to 5 years after construction).

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APPENDIX A

List of Common and Botanical Names

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List of Common Names and Botanical Names

Common Name	Botanical Name
Trees	
aspen	*Populus tremuloides*
balsam poplar	*Populus balsamifera*
Douglas fir	*Pseudotsuga menziesii*
limber pine	*Pinus flexilis*
lodgepole pine	*Pinus contorta*
narrow-leaf cottonwood	*Populus angustifolia*
Shrubs	
choke cherry	*Prunus virginiana*
mountain maple	*Acer glabrum*
red oiser	*Cornus stolonifera*
river alder	*Alnus tenufolia*
roses	*Rosa* spp.
sandbar willow	*Salix interior*
saskatoon	*Amelanchier alnifolia*
silverberry	*Elaeagnus commutata*
snowberry	*Symphoricarpos* spp.
thimbleberry	*Rubus parviflorus*
water birch	*Betula occidentalis*
willows	*Salix* spp.
Low shrubs	
common bearberry	*Arctostaphylos uva-ursi*
creeping juniper	*Juniperus horizontalis*
ground juniper	*Juniperus communis*

Grasses

bluebunch fescue	Festuca idahoensis
bluejoint	Calamagrostis canadensis
crested wheat grass	Agropyron cristatum
fowl blue grass	Poa palustris
intermediate wheat grass	Agropyron intermedium
Parry oat grass	Danthonia parryi
red fescue	Festuca rubra
rough fescue	Festuca scabrella
Russian wild rye	Elymus junceus
slender wheat grass	Agropyron trachycaulum
smooth brome	Bromus inermis
streambank wheat grass	Agropyron riparium
timothy	Phleum pratensis
wild oat grass	Danthonia californica

Herbs

alfalfa	Medicago sativa
alsike clover	Trifolium hybridum
balsam-root	Balsamorhiza sagittata
blazing star	Liatris punctata
blue phlox	Phlox alyssifolia
Columbia clematis	Clematis columbiana
Columbia puccoon	Lithospermum ruderale
cow parsnip	Heracleum lanatum
death camas	Zygadenus elegans
double bladder-pod	Physaria didymocarpa
fireweed	Epilobium angustifolium
horsetails	Equisetum spp.
meadow rues	Thalictrum spp.
milk vetch	Astragalus sp.
musineon	Musineon divaricatum
northern bedstraw	Galium boreale
perennial lupine	Lupinus sericeus
showy aster	Aster conspicuus
sticky purple geranium	Geranium viscosissiumum
stonecrop	Sedum stenopetalum
strawberries	Fragaria spp.
sweet clovers	Melilotus spp.
western Canada violet	Viola canadensis
yellow hedysarum	Hedysarum sulphursecens
yellow umbrella plant	Eriogonum flavum